

- diameter 48 of a reduced size, as compared to the outer diameter of the spacer body 50, for example by approximately 0.007 inches. This reduction in diameter for approximately 0.070 inches in length on an outer surface of the rim 42 provides a slight ledge and can facilitate the reception of an outer sealant 34 so that it is not removed nor
- 5 scraped off when the spacer 40 is inserted within an appropriate bore in a panel 16. This ensures that the outer sealant 34 is available to assist in providing a water-tight seal between the deformed or cold-worked rim 42 and the edge of the upper face plate perimeter about the bore hole. Again, an inner sealant material can be positioned within the inner diameter of the rim 42.
- 10 The body 50 can be provided, on its lower surface, with a pair of potting holes 52 to permit the installation of epoxy potting material to add additional strength to the mounted spacer. Each of the present embodiments can include the provision of such potting holes.

As seen in Figure 8, the curved surface 30 of the setting tool 28 contacts the  
15 beveled inner edge 46, and in cooperation with the groove 44 bends the rim 42 downward and outward to provide an annular bulge beneath the hole in the panel. The sealant 34 is compressed between the edge of the panel hole and the outer surface of the rim 42 to provide a water-tight seal. Any excess sealant on the surface of the panel 16 can be wiped off.

20 Another embodiment of the spacer of the present invention can be seen as spacer 54 in Figure 9, and in this embodiment, a V-shaped groove 56 can be provided around the body portion 58 so that it can also carry and support the outer sealant 34.

Referring to Figure 6, a partial cross-sectional perspective view of the combination spacer and composite panel of the present invention is disclosed, wherein

fasteners can be readily attached, while maintaining a water-tight seal, for example, on a floor panel of an airplane. As can be seen in Figure 10, the improved panel 20 with a series of spacers 40 permits fasteners, such as screws 60, to extend through the panel 20 and to be anchored to a bulkhead such as a C-shaped beam 62. A lock nut 64 can secure 5 the fastener 60 so that the heads of the fasteners are flush with a horizontal upper surface of the panel 20. The sealants insure a water tight seal on both the perimeter of the spacer 40 and to the head of the fastener 60.

The panel 20 can be automatically drilled with the spacers 40 installed in the panel 20 and then forced into a lock position automatically by application of the contact 10 face of the setting tool 28. The first sealant is spread about the perimeter when the contact face of the setting tool 28 drives the rim of the spacer 40 downward to be flush with the panel surface. The spacer 40 is further deformed to provide a convex bulge to secure the spacer 40 to the panel. The plurality of fasteners help distribute the load on the panel to the beam 62. The second sealant within, the spacer helps seal the head of 15 the fastener whereby a watertight seal is provided to the floor panel.

Finally, while not shown, the setting tool 28 can have a replaceable contact surface to permit repairs and rebuilding of the tool.

Figure 12 discloses an alternative embodiment of the spacer of the present invention which also, like the other embodiments, can be a unitary metallic spacer that is 20 machined from an appropriate bar stock. The spacer 70 has an upper outer cylindrical surface 72 that supports a thin coat of the sealant material 74. The base of the spacer 70 includes the enlarged flange 76 with an annular coating of an adhesive 78 to permit the attachment to a panel face. A lower serrated cylindrical surface 80 is positioned immediately above the flange 76 and is slightly larger in diameter than the upper

cylindrical outer surface 72. Surface 80 provides a hole engaging surface for a friction fit with the lower panel face and other surface engaging configurations can be used. The splines or serrations can number approximately 26 equally spaced teeth with the tooth pattern running horizontal about the bore 82 of the spacer 70. Each tooth can have a

5 horizontal angle of approximately 45°. The major and minor diameters of the splines are selected to provide an adequate engagement with the hole in the lower panel face skin.

An intermediate body portion of the spacer 70 can have an annular concave groove 86 of a dimension to ensure sufficient integrity and strength to the spacer 70 while maintaining the dimensions of the internal bore 82. The groove 86 enables a weight reduction to the

10 spacer 70 and if auxiliary potting material is used, it helps to further secure the spacer 70 within a sandwich panel by anchoring the spacer within the potting compound. At the top of the serrations or splines 80, a vertically slanted lead angle, e.g., 30° or 45° is formed to act as a guide or lead in to the splines 80 to initially engage the hole in the panel during insertion of the spacer 70. This lead angle assists in permitting the

15 serrations 80 to friction engage the hole, bored for example in a fiberglass panel sheet and to reduce any delamination effect.

The provision of the serrations 80 having a slightly larger diameter than the upper cylindrical surface 72 assists in minimizing problems that can occur in the automatic installation of spacers in honeycomb composite panels in a production

20 environment. In such an environment, large honeycomb composite panels can incorporate multiple spacers and can be subject to rough handling before and during an accelerated cure of the adhesive on the flanges. Additionally, the drilling of holes in the honeycomb composite panels may be slightly off-centered in larger and out of round